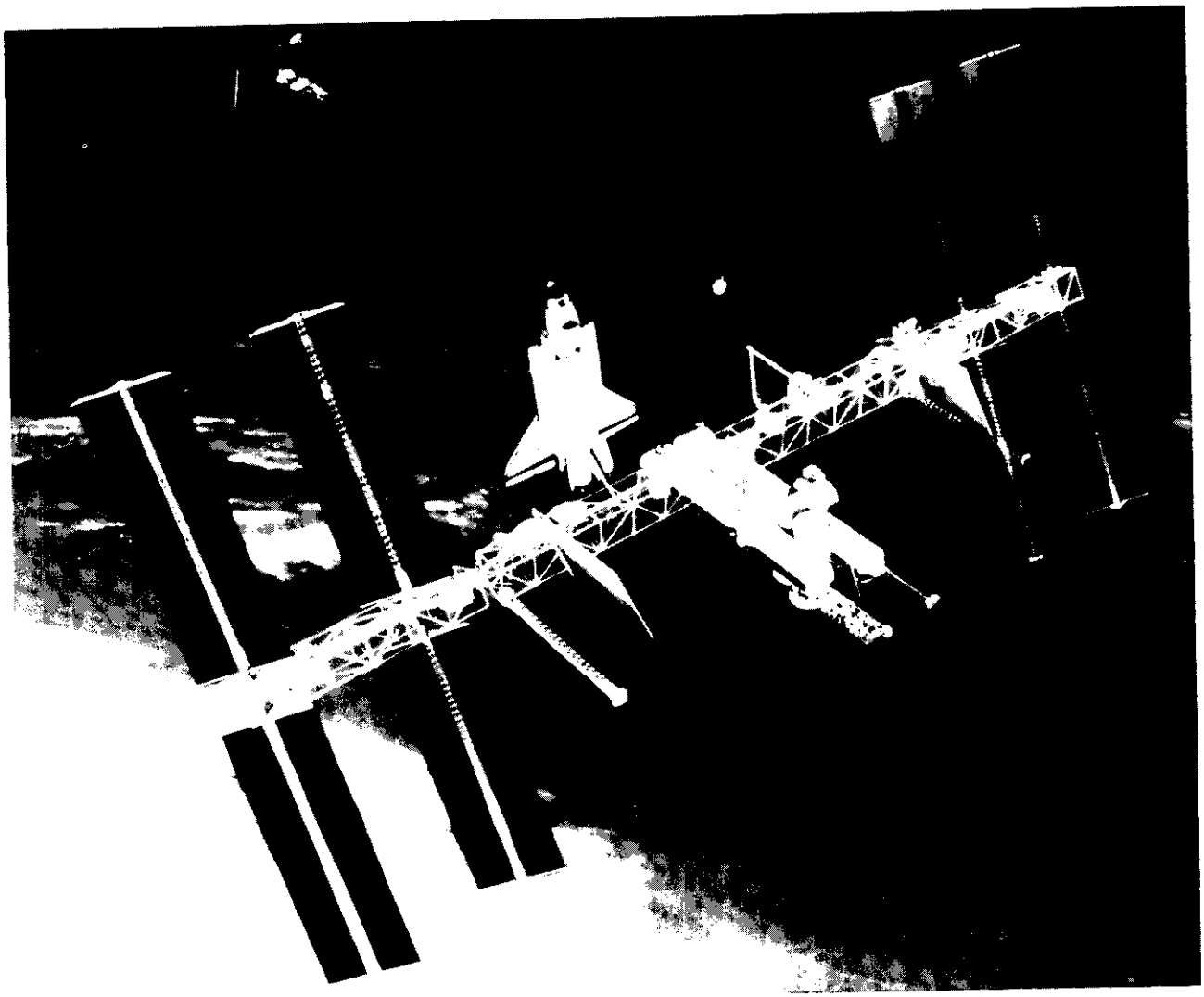
Chapter 5

Space Transportation and the Space Station



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An artist's conception of Space Station *Freedom,* which is scheduled for completion by the end of the century.

Box 5-A-Escape Vehicles

Several contingencies could require emergency escape of personnel in space. These include medical emergencies of Space Station crewmembers, major equipment failures, damage from orbital debris, etc. Escape **could also be necessary if the Shuttle failed to meet its scheduled launch date by so long a time that the Station risked running out of critical supplies.**

Crew Emergency Return Vehicles (CERV)

NASA is considering two types of vehicles for emergency return from space to Earth:

- Capsule—This simple vehicle would have an ablative heat shield reminiscent of reentry capsules from the early days of spaceflight, and still used routinely by the Soviet Union. A capsule, which could closely resemble the Apollo capsule, would descend by parachute and land in the ocean. Its advantages include simplicity, relatively low cost, and proven technology, In addition, capsules need little or no piloting, which could be a major consideration if pilots are unavailable or unable to function as a result of injury or a long stay in orbit. Depending on its capability, a capsule could cost $0.75 billion to $1.0 billion to develop.
- Small Glider-A small, aerodynamically stable vehicle whose shape would provide lift and could land by parachute or at low speed on a runway. A glider could reach a wider range of landing sites and have more opportunities for reentry and recovery (particularly for a version with landing gear), and a softer ride than capsules (important if an injured crew member is returning). However, a glider would cost 20 to 50 percent more than the simplest parachute version of a capsule.

ingly, even eagerly, accept such duty despite the inherent risks of spaceflight. Although they should not expect to be exposed to unnecessary risks, their duty will never be risk free.

A rescue system, if built, would be needed for the life of the Space Station. Therefore, its total operating costs can be expected to exceed its development costs. **Before committing to a specific rescue strategy, system designers will have to address the costs of developing the necessary support infrastructure, which might include ground operations hardware and personnel at the mission control site, landing site crews, and the necessary subsystems and logistics support to resupply, replenish, and repair a rescue vehicle on orbit.**

The NASP program is also evaluating the potential for using an operational aerospace plane for Space Station crew rotation and rescue. Using an aerospace plane for rescue would provide two primary advantages: 1) there would be no need to build and support a dedicated vehicle and its associated infrastructure and personnel; and 2) it could be based on Earth, rather than in space, making it easier and cheaper to maintain. However, NASA expects to complete Phase I of the Space Station before 2000, and an operational aerospace plane could not be ready before it does so. Hence, an aerospace plane could not serve to replace or rescue crew from the Space Station until 2005 or later, if at all.

The planned international Space Station will make long-term demands on space transportation for construction, servicing, supply, and possibly emergency crew return. Current NASA plans call for making at least 29 Shuttle flights (including several logistics flights) between 1995 and 1999 to build the station, and about 5.5 flights per year thereafter to operate it. Some flights will be required to rotate station crew, some for delivering or returning cargo.

SPACE SHUTTLE

Uncertainty about the adequacy of the current Shuttle fleet for constructing and servicing the Space Station makes station planning uncertain and risky. Deployment, servicing, and resupply of the Space Station face the dual risks of delayed launch schedules and loss of one or more orbiters. In addition, losing a critical element of the Space Station in transit to orbit as a result of a Shuttle failure could lead to long delays in Space Station constructional

Chapter 4 outlined options for reducing the risk of using the Shuttle for Space Station construction and operation. However, most of these options would require additional funding beyond NASA's projected budget for Space Station or for space transportation. **Congress may wish to postpone Space Station construction and operation and focus on improving the Nation% ability to place crews in orbit safely and reliably. Alternatively, Congress could direct NASA to fly fewer non-Space Station-related Shuttle missions in order to reduce the risk that a Shuttle would be lost before Space Station construction is completed.**

NASA might, for example, plan to use Titan IVs to carry some Space Station elements into orbit rather than risking the Shuttle to do so. However, the availability of Titan IV is highly uncertain, as the Air Force appears to need all the Titan IVs it has purchased for the period of station construction. NASA might also develop the Shuttle-C for Space Station construction. Furthermore, as noted earlier, science payloads now tentatively manifested for the Shuttle, if properly designed, could be flown on ELVs purchased competitively from the private sector.

RESCUE OR ESCAPE VEHICLES

Crews living and working in the planned Space Station could be exposed to substantial risk from major failures of the Station or the Space Shuttle that transports the crew. For example, orbital debris from previous space activities could puncture one of the crew modules, causing a need to evacuate the crew and return them to Earth.* NASA is attempting to reduce such risk by building safety features into the Space Station and improving the Shuttle's design. Nevertheless, many analysts in NASA and the broader U.S. space community believe that the United States should develop some means independent of the Shuttle to rescue crews from the Space Station.

NASA is studying the possibility of building a specialized vehicle that could be launched into space atop an expendable launch vehicle as well as return from the Space Station (box 5-A). Such a vehicle, which NASA calls the Assured Crew Return Vehicle (ACRV),[3] could be used to provide:

1. crew emergency rescue,
2. access to space by crews,
3. small logistics transport, and
4. on-orbit maneuver.

Emergency rescue vehicles could be developed and launched on a Titan III or Titan IV by 1995 or 1996. Alternatively, a Shuttle could carry two at a time, to be docked at the Space Station.

To decide whether a risk-reducing effort is worth the investment required, Congress must be advised about how much the investment would reduce the risk. Even if an alternate crew return capability were provided and worked as planned, it would not eliminate all risks to station crewmembers. To gain perspective on the decision, Congress may wish to weigh the risks with and

[1]If a Space Station element for which there was no spare were lost, replacing that element would take many months.

[2]In 1983, a paint chip from a space object severely damaged a windshield on the Shuttle orbiter *Challenger*. Nicholas L. Johnson and Darren S. McKnight, *Artificial Space Debris* (Malabar, Florida: Orbit Book Company, 1987), pp. 4-5.

[3]Note, however, that although the ACRV may provide a high probability of return from space, it does not necessarily provide assured safe return, as there will still be a non-negligible degree of risk connected with the vehicle and the procedures required to operate it properly.

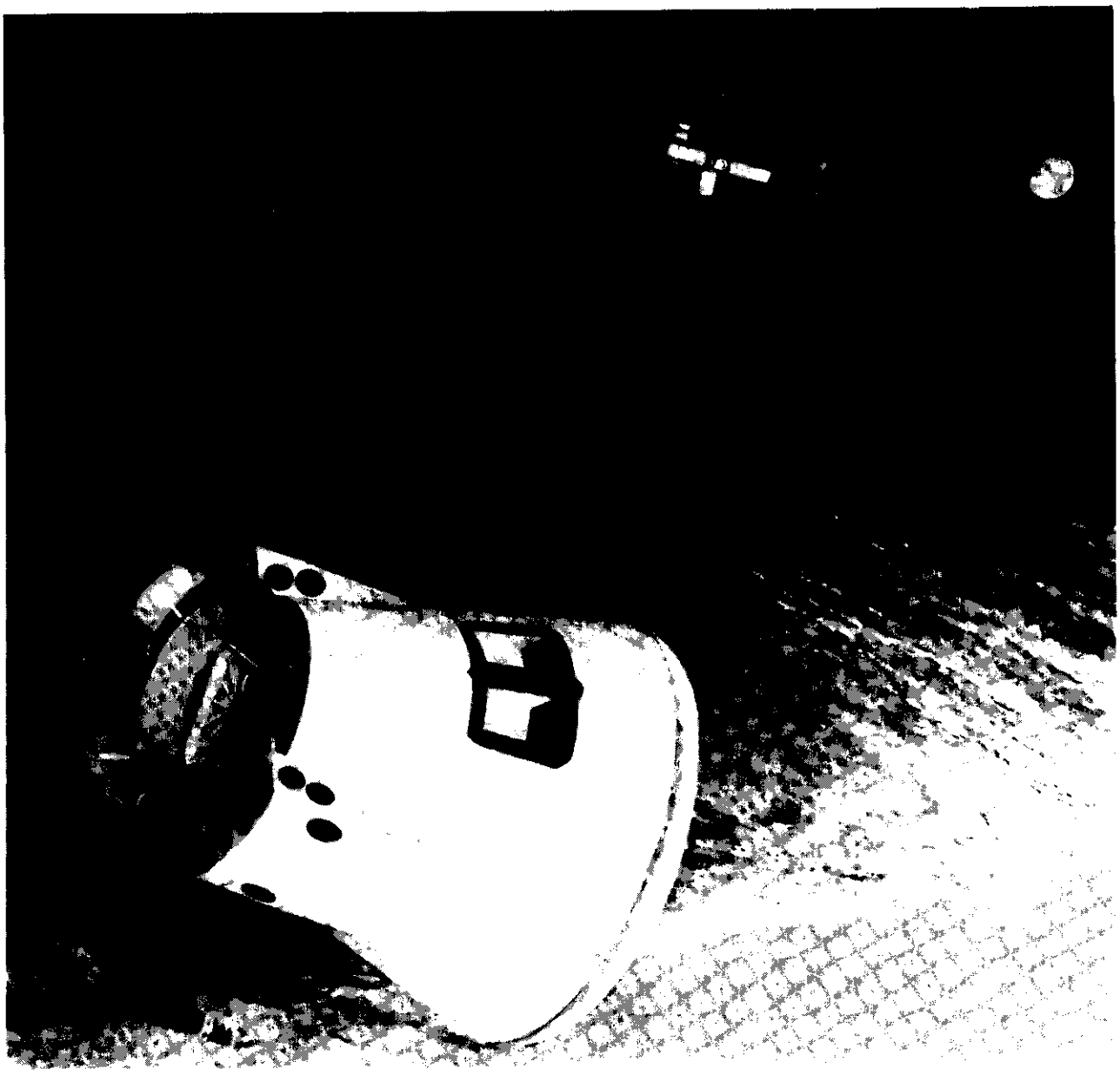

Photo credit: ***National Aeronautics and Space Administration***

Artist's conception of an Apollo-type emergency rescue vehicle entering the Earth's atmosphere after leaving the Space Station.

without a rescue vehicle against the risks of other hazardous duty in the national interest.[4]

A risk assessment of the Space Station should take into account all phases of the crews' experience in space. For example, if the greatest risk to Space Station crewmembers were experienced during flight to orbit, it may prove more cost-effective to improve the safety of the Shuttle or any later crew-carrying space transportation systems than to build a crew escape craft. **The use of a rescue system would itself expose Space Station crewmembers to a certain element of risk, which must also be assessed before making any decision about whether or not to build such a system.** Finally, it would be well to remember that the Space Station crew will be volunteers, who would will-

[4]For example, working on off-shore oil platforms, or piloting experimental aircraft.